Shuttle Propulsion Overview to NATO

Abstract

In the early morning on Saturday, February 1, 2003, the Space Shuttle Columbia broke up during entry. After extensive investigation of the accident and recommendations made by the Columbia Accident Investigation Board, President Bush gave the vision for space exploration for NASA, which include return the Space Shuttle to flight as soon as practical, complete assembly of the ISS by the end of the decade, initiate robotic missions to the moon no later than 2008, develop a new Crew Exploration Vehicle, conduct first robotic, then human missions to Mars and extend human exploration across the solar system.

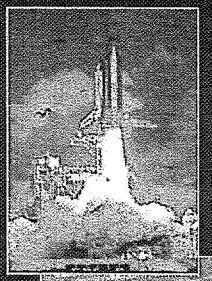
Shuttle Propulsion Overview to

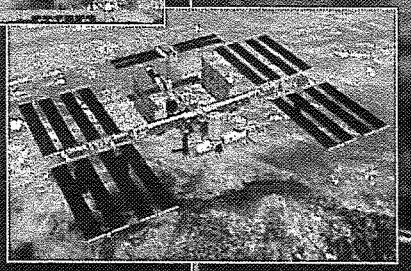
NATO
Central European Pipeline Management Organization (CEPMO)
Board of Directors

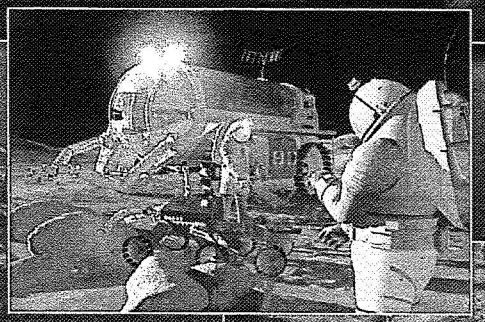
Robert Lightfoot
Deputy Program Manager,
Space Shuttle
May 18, 2006

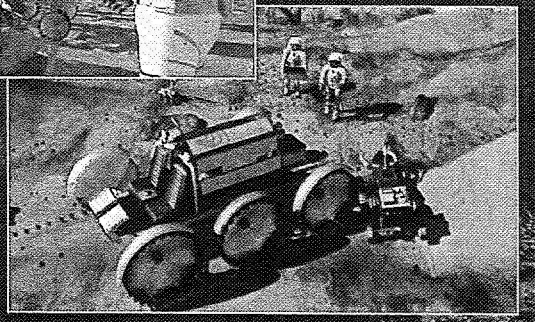
The Vision for Space Exploration

- **Return the Space Shuttle to flight as soon as practical**
- Complete assembly of the ISS by the end of the decade
- Initiate robotic missions to the moon no later than 2008
- Develop a new Crew Exploration Vehicle …first crewed mission by 2014
- Conduct first robotic, then human missions to Mars
- Extend human exploration across the solar system



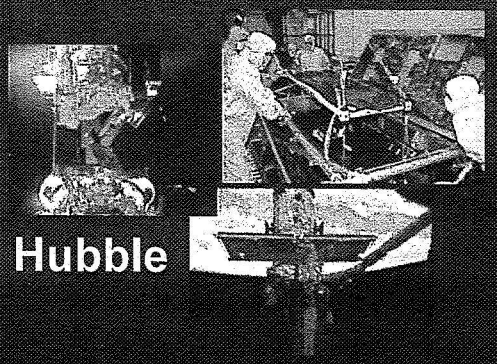


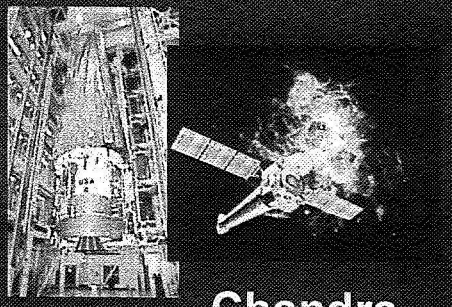


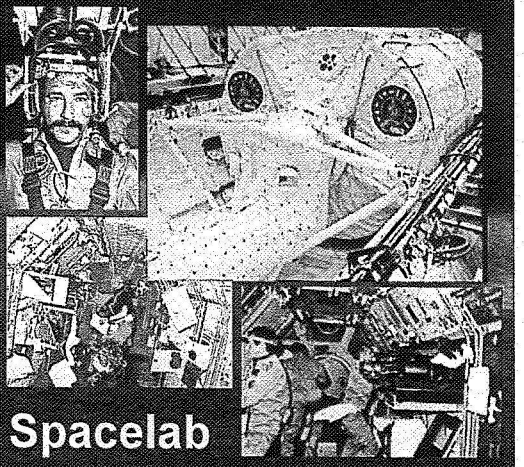


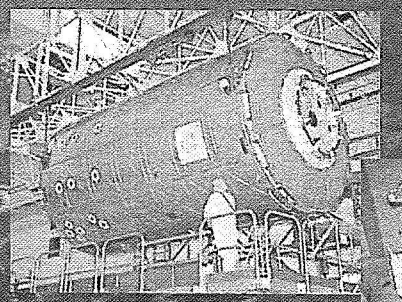
Space Shuttle History

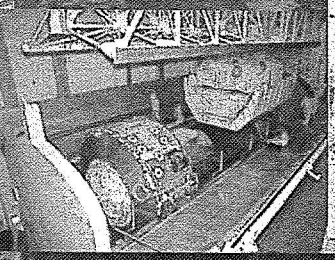
- Great Observatories
  - Chandra
  - Hubble
- Spacelab
- Space Station

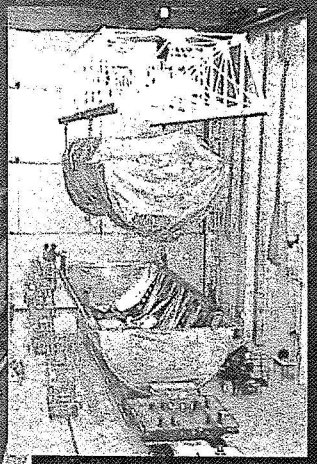

Hubble


Chandra


Spacelab

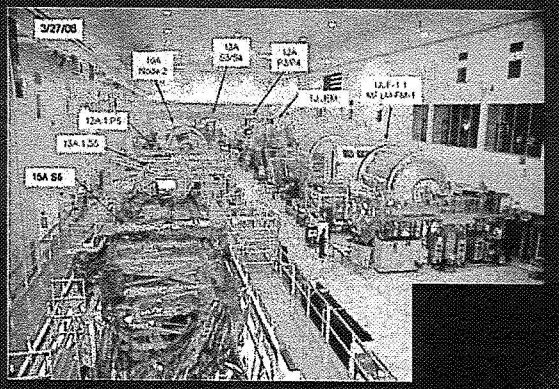


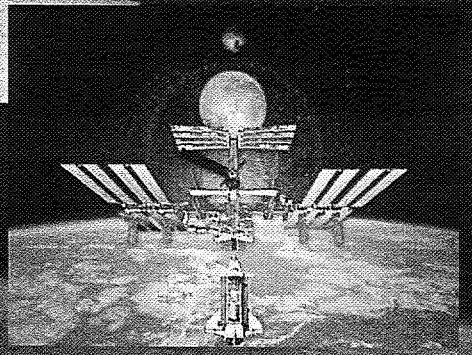

Space Station



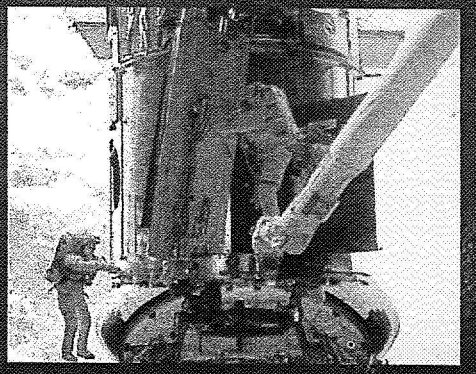
Remaining Shuttle Missions

- Completion of ISS (18 missions)
- Hubble Servicing
- Retire the Shuttle System in 2010

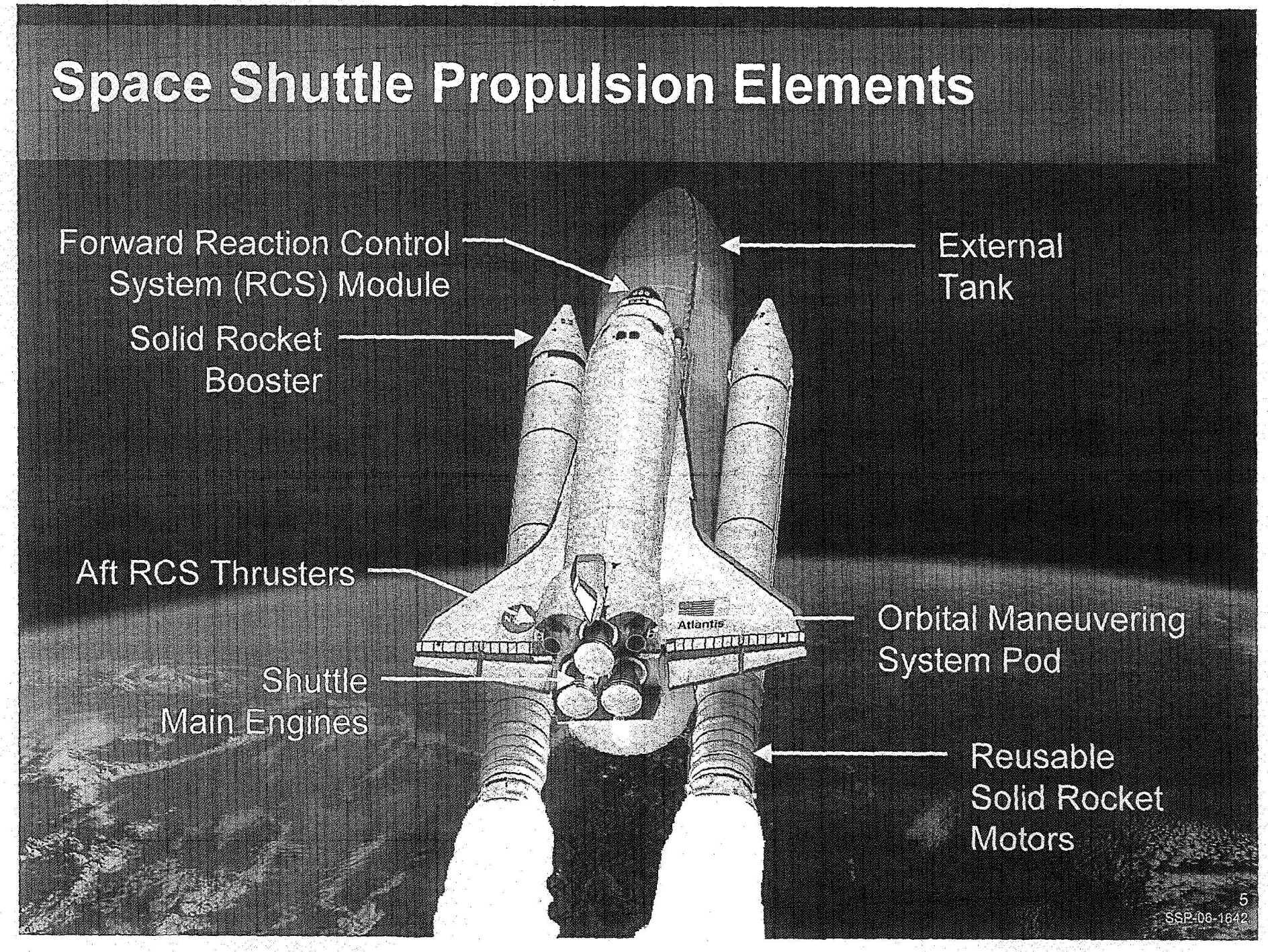




Final configuration



Space Shuttle Propulsion Elements



Space Shuttle Propulsion Elements: External Tank

External Tank Components/Functions:

- Liquid oxygen tank
- Liquid hydrogen tank
- Intertank

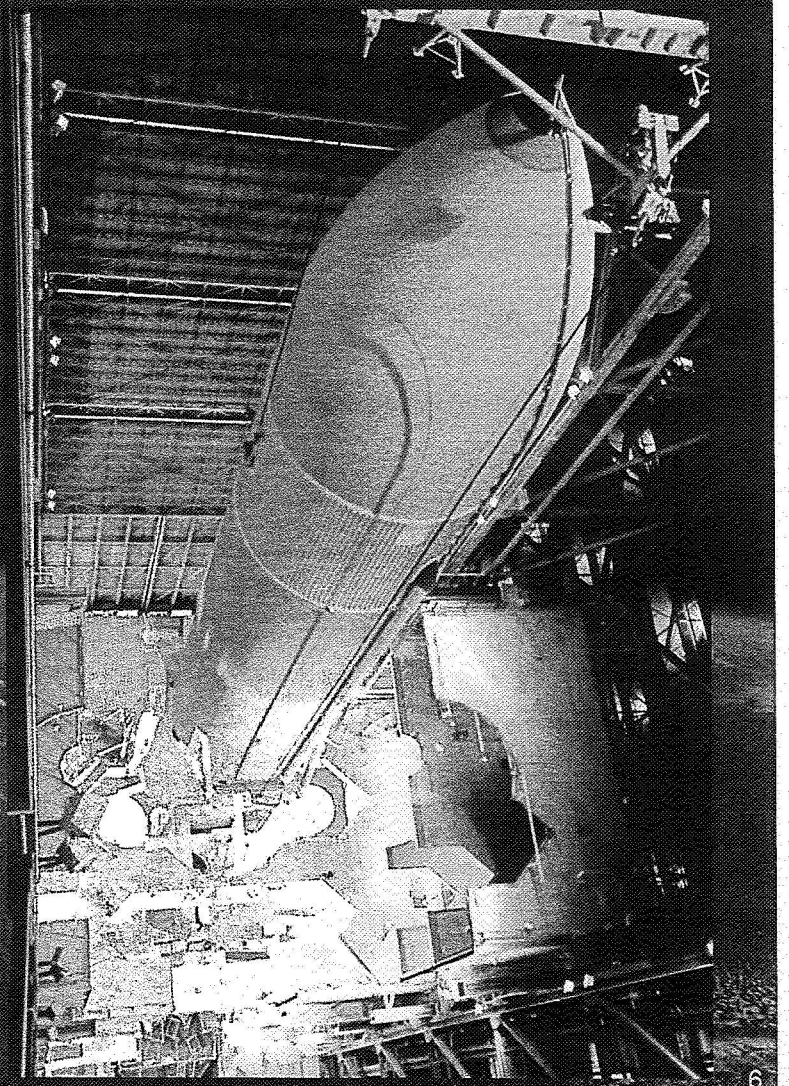
Manufactured in New Orleans, LA

Structural backbone of the assembled vehicle

Tank Capacities: Liquid hydrogen 380,000 gallons
Liquid oxygen 140,000 gallons

Weight: 1,667,667 lbs (at liftoff)
78,100 pounds (empty)

Dimensions: 152.8 Feet in length
27.5 Feet in diameter



Space Shuttle Propulsion Elements: Solid Rocket Boosters

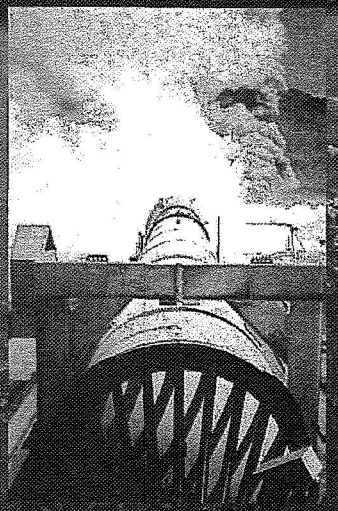
Rocket Type:
- Solid Propellant, controllable nozzle
- Manufactured in four segments, stacked at KSC in the Vertical Assembly Building (VAB)
- Reusable

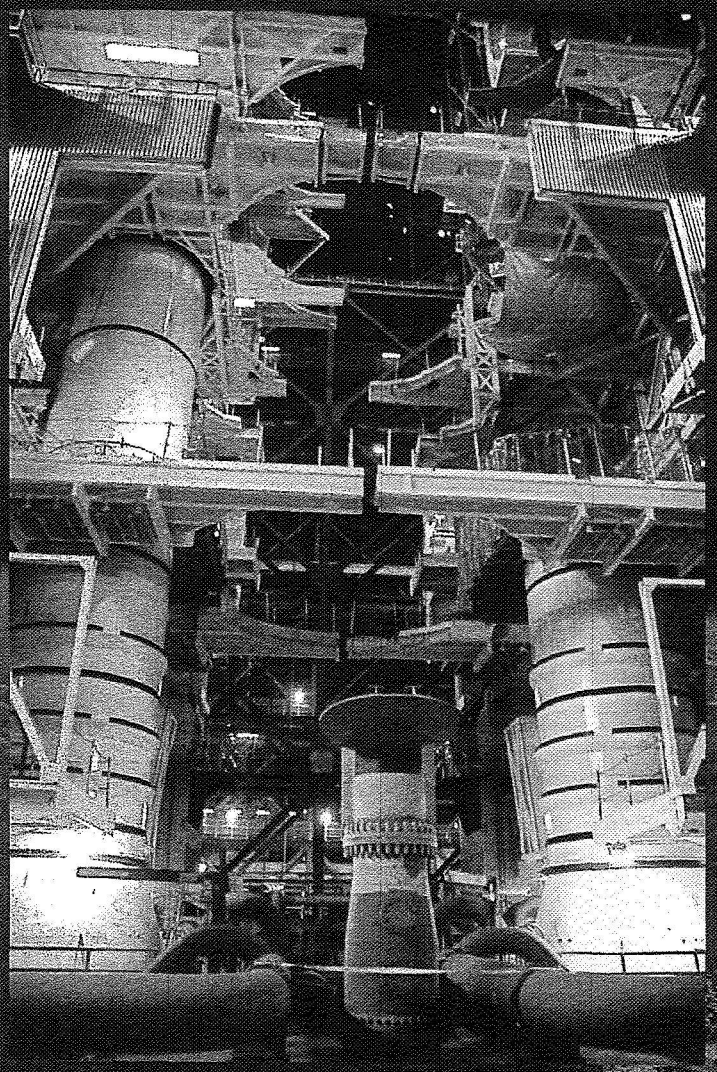
Manufactured in Promontory, UT and KSC

Thrust at lift-off: 2,650,000 pounds

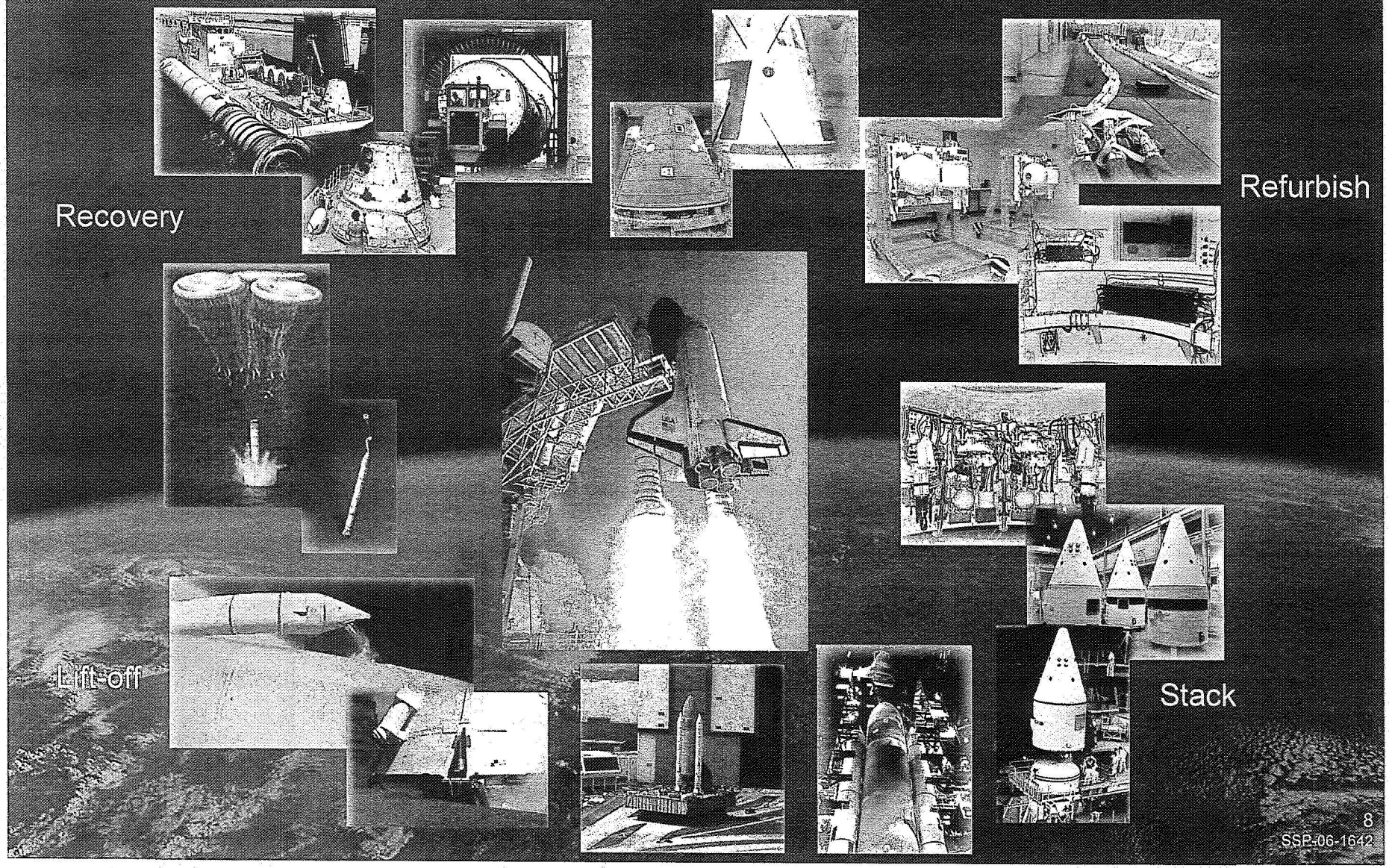
Loaded Boosters at lift-off: 1,300,000 lbs

Burn time: 123.4 Seconds





Space Shuttle Propulsion Elements: Solid Rocket Boosters Lifecycle



Space Shuttle Propulsion Elements: Space Shuttle Main Engines

Thrust Sea Level: 375,000 pounds

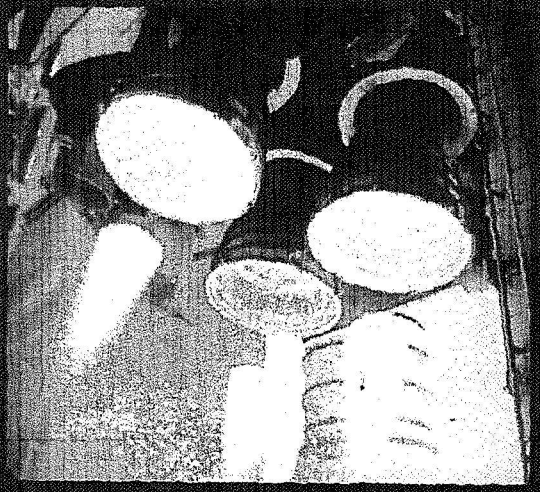
Vacuum: 470,000 pounds

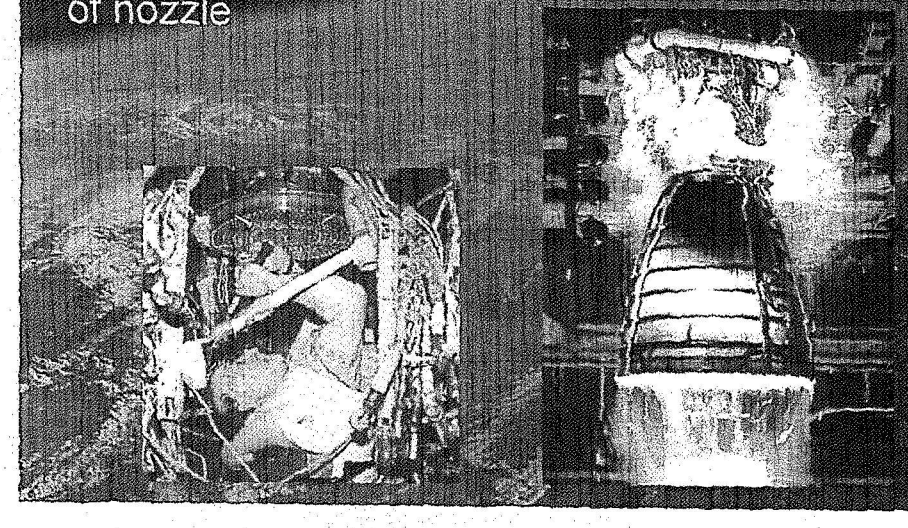
Nominal operating time: 8.5 minutes after liftoff

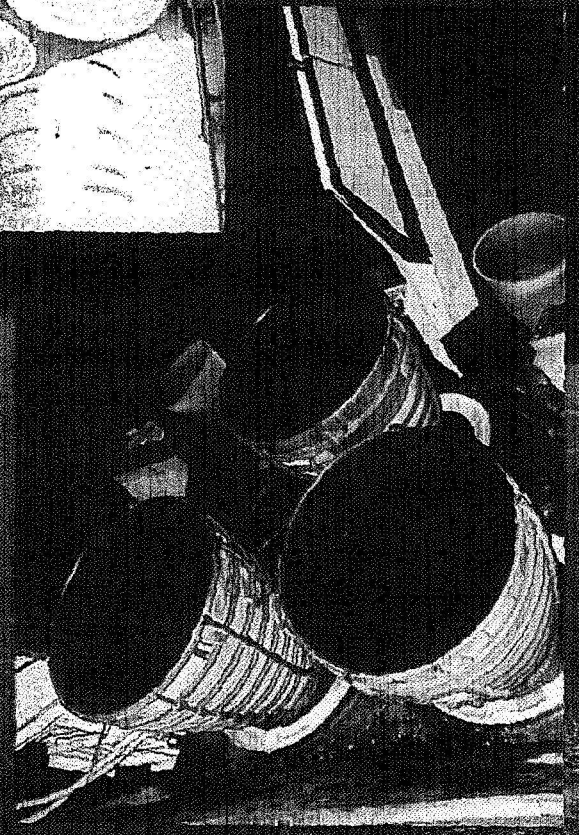
Operate on Liquid Hydrogen and Liquid Oxygen provided by the External Tank

Weight: Approximately 6,700 pounds each

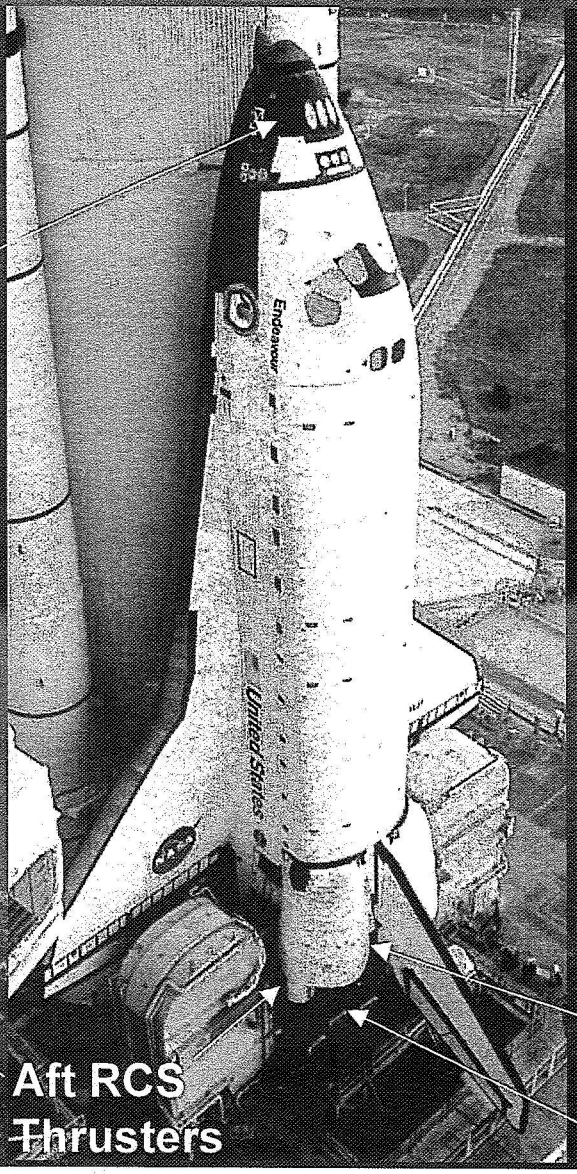
Dimensions: 14 feet long 7.5 feet wide at mouth of nozzle



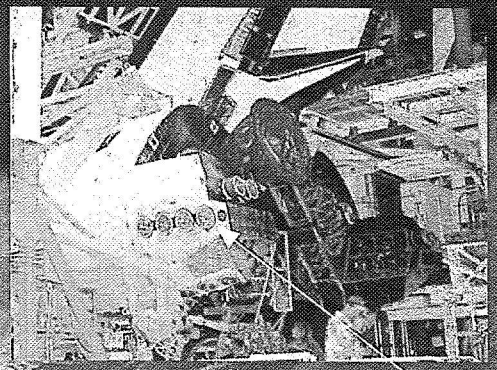




Space Shuttle Propulsion Elements: Shuttle Orbiter

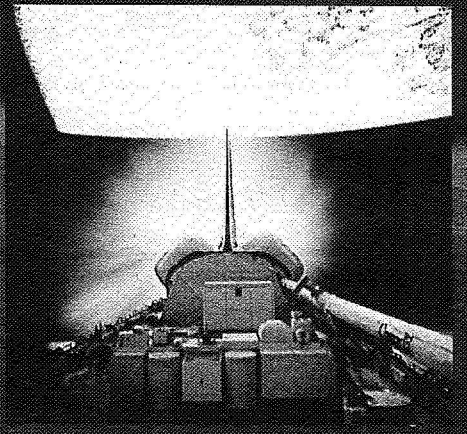


Forward RCS Module



Aft RCS Thrusters

OMS & RCS Modules



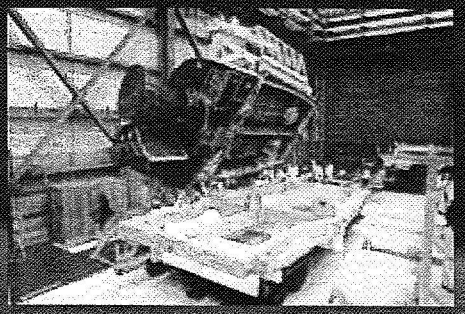
OMS Pod

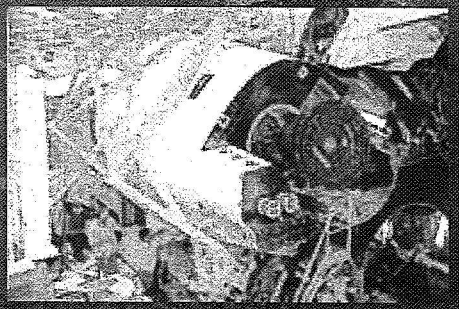
OMS Engine

Space Shuttle Propulsion Elements: Shuttle Orbiter

OMS System Description

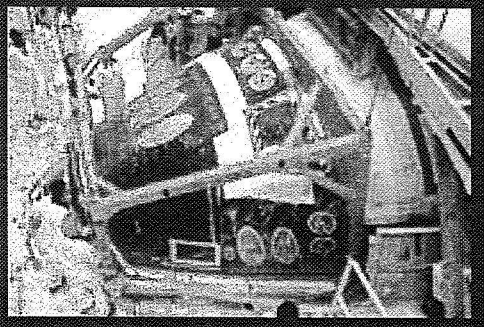
- Orbital Maneuvering System :
  - Housed in two independent pods located on each side
    - One OMS engine and the hardware to pressurize, store, and distribute propellants
    - Pods contain the aft RCS
  - Propellants:
    - Fuel: Monomethyl hydrazine (MMH)
    - Oxidizer: Nitrogen Tetroxide (NTO)
  - Provides thrust for Orbit Insertion, Circulation, Transfer, Rendezvous, De-orbit, Abort to orbit and abort once around



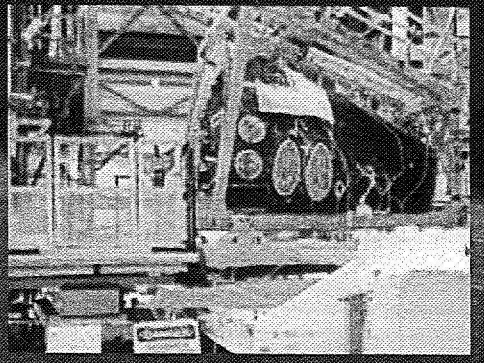


Space Shuttle Propulsion Elements: Shuttle Orbiter

RCS System Description

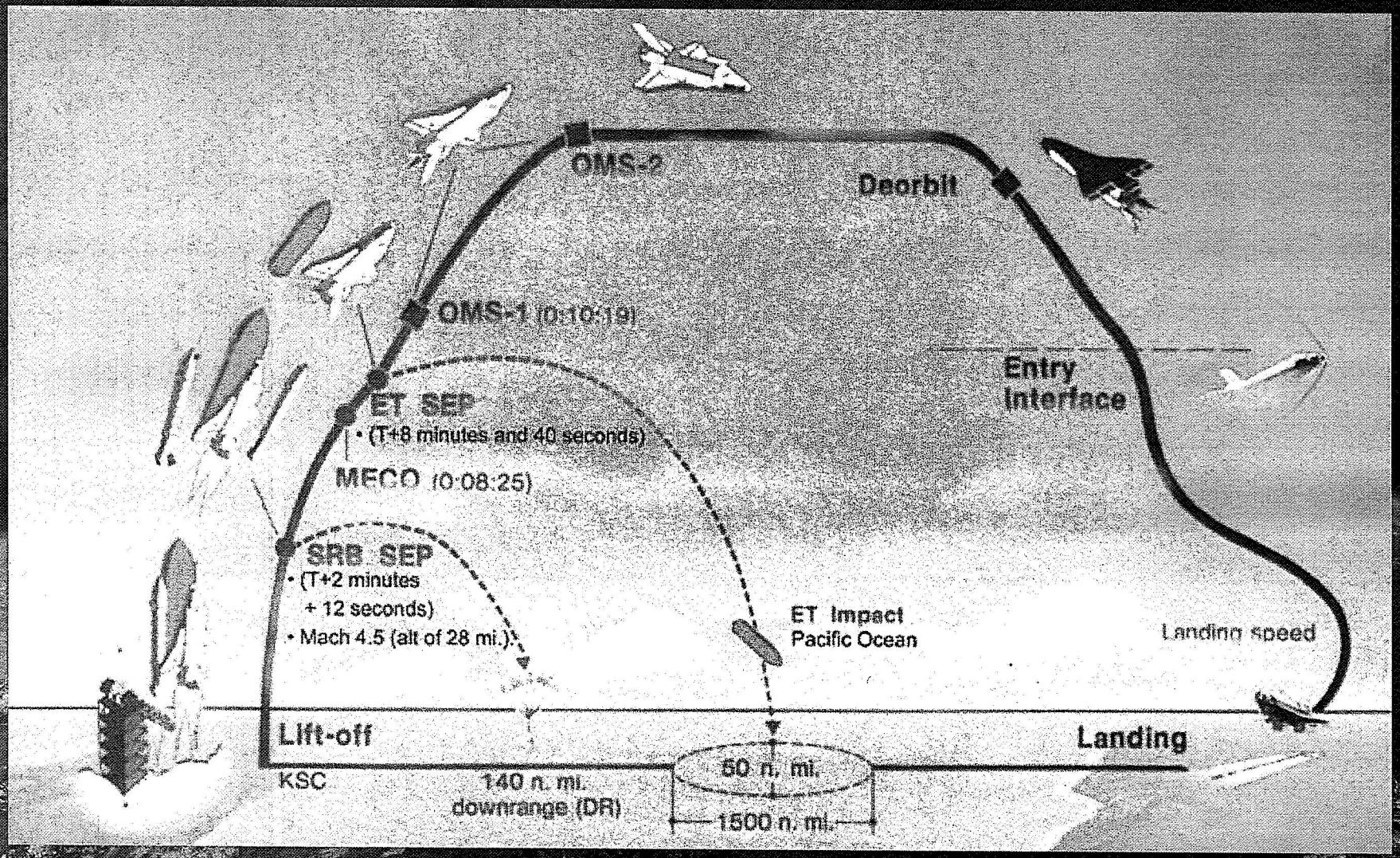


- Reaction Control System:
  - RCS consists of three separate system:
    - Forward module
      - 14 primary and 2 vernier thrusters
    - One in each of the two aft Pods, structurally integrated with the OMS
      - 12 primary and 2 vernier thrusters
    - Hardware to pressurize, store, and distribute propellants



  - Propellants:
    - Fuel: Monomethyl hydrazine (MMH)
    - Oxidizer: Nitrogen Tetroxide (NTO)
  - Provide the thrust for the attitude (rotational) maneuvers (pitch, yaw, and roll) and for small velocity changes along the orbiter axis (translation maneuvers), +X de-orbit maneuver and ISS reboost

Space Shuttle Propulsion Elements: Mission Profile



Columbia Accident

- In the early morning on Saturday, February 1, 2003, the Space Shuttle Columbia broke up during entry. All seven crew members were killed.
- An extensive investigation of the accident determined that 81 seconds after launch, foam insulation on the External Tank broke off and struck the Shuttle's wing at Mach 2.46, creating a hole roughly the size of a pizza box.
- NASA did not have the technology readily available to detect the foam loss or the damage.
- When Columbia reentered the atmosphere to land, highly heated plasma entered the breached wing, and burned or melted away the wing's internal structure. The structural failure of the wing led to the loss of vehicle control and the vehicle broke apart as it descended toward Earth.

The Crew of the Space Shuttle Columbia, STS-107

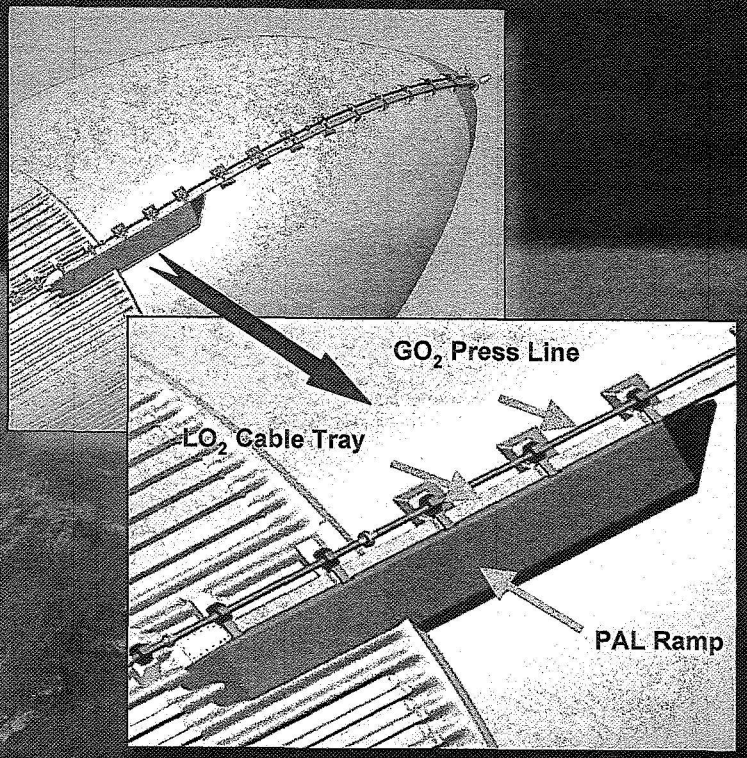
Space Shuttle Program Status

- Launch window for STS-121 July 1 - July 19, 2006

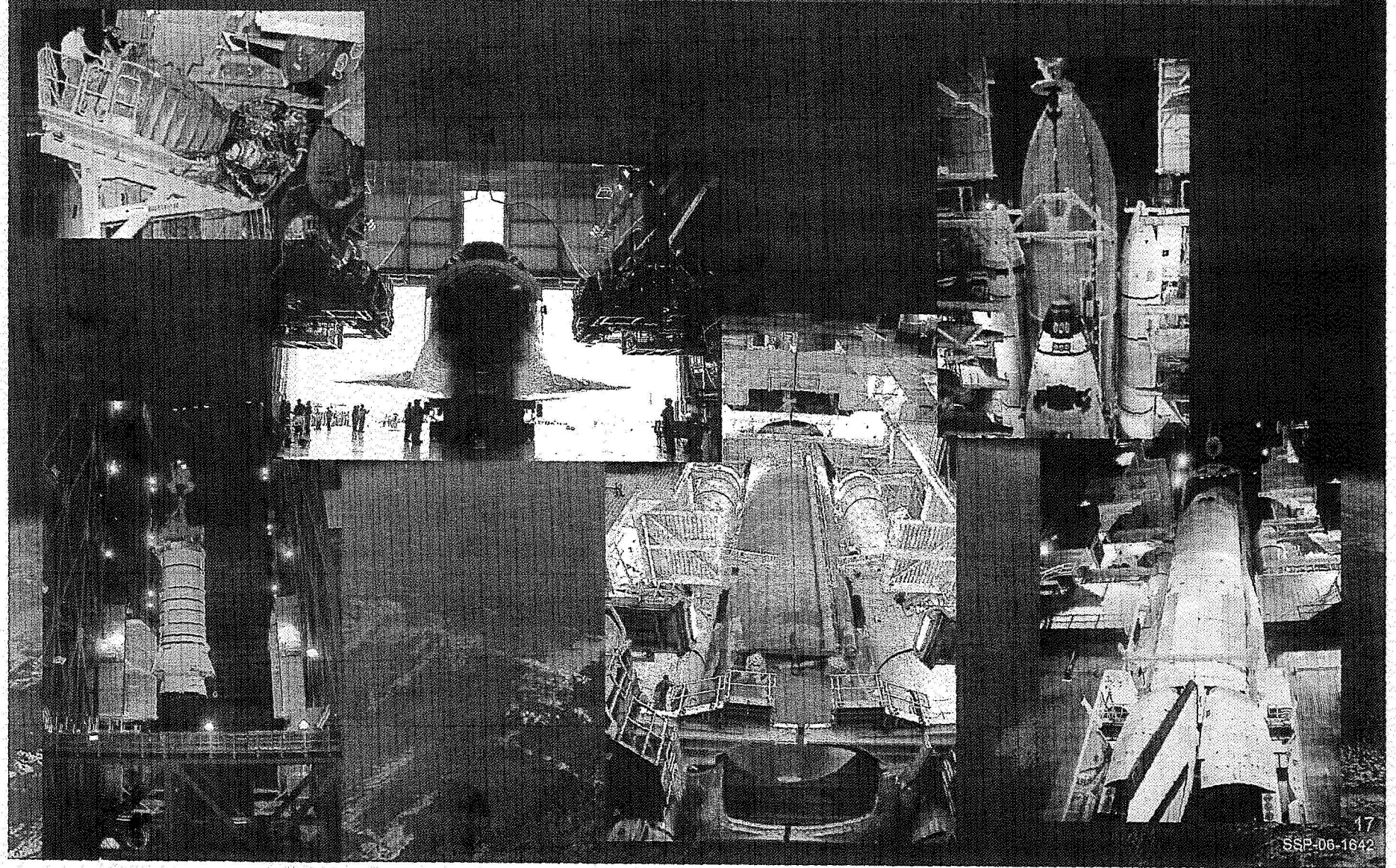
STS-121 crew, pictured from left to right: Stephanie D. Wilson, Michael E. Fossum, Steven W. Lindsey Piers J. Sellers-Cmdr., Mark E. Kelly-Pilot, Lisa M. Nowak

Preparing for a Second Return to Flight Mission

- Space Shuttle Program is planning to remove the PAL Ramps and Bipod Ramps from the External Tanks



Space Shuttle Program Status: Preparations for Launch



Space Shuttle Propulsion Elements Summary

- Return To Flight marked a major milestone in the Vision for Space Exploration
- The Program continues to improve safety and is committed to maintaining Shuttle safety through the end of the Program
- We will continue to improve the system and continue tests on STS-121